MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2021/2022

DCT5036 – FIELD THEORY

(Diploma in Electronic Engineering)

11 AUGUST 2022
9.00 a.m – 11.00 a.m
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of **4** pages (excluding cover page)
2. Answer **ALL** questions. All necessary working steps must be shown.
3. Please write all your answers in the answer booklet provided.

QUESTION 1 [25 MARKS]

a) Three point charges, q1, q2 and q3 are placed at the following points on x-axis, as in Figure 1. Find the force on q2.

[16 marks]

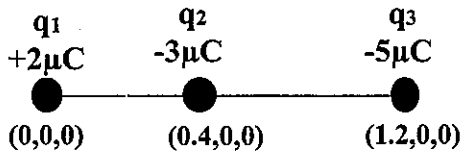

Figure 1

b) Two capacitors, $C_1 = 4\ \mu F$ and $C_2 = 8\ \mu F$, are connected in parallel, and the combination is connected to a 10V battery. Find:

i) the equivalent capacitance of the combination.

[2 marks]

i) the potential difference across each capacitor

[1 marks]

ii) the charge stored on each of the capacitor.

[3+3 marks]

Continued...

QUESTION 2 [25 MARKS]

a) A 5 Wb/m^2 magnetic field is directed perpendicular to the plane of a 50 turn loop which has a radius of 0.2 m. The loop is rotated 180° in 0.2 s. Determine the magnitude of the induced emf in the loop.

[14 marks]

b) A 30 cm long solenoid, 1.5cm in diameter is to produce a 0.4T magnetic field at its center.

(i) If the maximum current is 5A, how many turns must the solenoid have?

[4 marks]

(ii) If it has 1000 turns of the wire, how much current should the solenoid carry?

[4 marks]

c) Three inductors of 20mH, 40mH and 50mH are connected together in a series combination with no mutual inductance between them. Calculate the total inductance of the series combination.

[3 marks]

Continued...

QUESTION 3 [25 MARKS]

a) Sketch the hysteresis loop of a ferromagnetic material and label all the following points:
   i) Saturation
   ii) Retentivity
   iii) Coercivity

[15 marks]

b) Give **three** similarities and **two** differences between electric circuit and magnetic circuit.

[6 + 4]

QUESTION 4 [25 MARKS]

a) An ideal transformer has primary voltage of 30V, 100 turns and draws a current of 15A. Given that the required output voltage from the transformer is to be 150V. Determine:

(i)	the turns ratio of the transformer.	[3 marks]
(ii)	the secondary number of turns.	[3 marks]
(iii)	the secondary current.	[3 marks]
(iv)	the input power.	[3 marks]
(v)	the output power.	[2 marks]

b) How much primary voltage must be applied to a transformer with a turns ratio of 0.2 to obtain a secondary voltage of 10V?

[4 marks]

c) Determine the voltage across the load in Figure 4.

[7 marks]

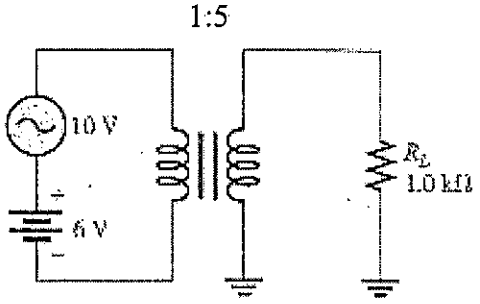

Figure 4

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APPENDIX

Transformation	Coordinate Variables	Unit Vectors	Vector Components
Cartesian to Cylindrical	$r=\sqrt{x^2+y^2}$ $\phi=\tan^{-1}(y/x)$ $z=z$	$\hat{r}=\hat{x}\cos\phi+\hat{y}\sin\phi$ $\hat{\phi}=-\hat{x}\sin\phi+\hat{y}\cos\phi$ $\hat{z}=\hat{z}$	$A_r=A_x\cos\phi+A_y\sin\phi$ $A_\phi=-A_x\sin\phi+A_y\cos\phi$ $A_z=A_z$
Cylindrical to Cartesian	$x=r\cos\phi$ $y=r\sin\phi$ $z=z$	$\hat{x}=\hat{r}\cos\phi-\hat{\phi}\sin\phi$ $\hat{y}=\hat{r}\sin\phi+\hat{\phi}\cos\phi$ $\hat{z}=\hat{z}$	$A_x=A_r\cos\phi-A_\phi\sin\phi$ $A_y=A_r\sin\phi+A_\phi\cos\phi$ $A_z=A_z$
Cartesian to Spherical	$R=\sqrt{x^2+y^2+z^2}$ $\theta=\tan^{-1}(\sqrt{x^2+y^2}/z)$ $\phi=\tan^{-1}(y/x)$	$\hat{R}=\hat{x}\sin\theta\cos\phi+\hat{y}\sin\theta\sin\phi+\hat{z}\cos\theta$ $\hat{\theta}=\hat{x}\cos\theta\cos\phi+\hat{y}\cos\theta\sin\phi-\hat{z}\sin\theta$ $\hat{\phi}=-\hat{x}\sin\phi+\hat{y}\cos\phi$	$A_R=A_x\sin\theta\cos\phi+A_y\sin\theta\sin\phi+A_z\cos\theta$ $A_\theta=A_x\cos\theta\cos\phi+A_y\cos\theta\sin\phi-A_z\sin\theta$ $A_\phi=-A_x\sin\phi+A_y\cos\phi$
Spherical to Cartesian	$x=R\sin\theta\cos\phi$ $y=R\sin\theta\sin\phi$ $z=R\cos\theta$	$\hat{x}=\hat{R}\sin\theta\cos\phi+\hat{\theta}\cos\theta\cos\phi-\hat{\phi}\sin\phi$ $\hat{y}=\hat{R}\sin\theta\sin\phi+\hat{\theta}\cos\theta\sin\phi+\hat{\phi}\cos\phi$ $\hat{z}=\hat{R}\cos\theta-\hat{\theta}\sin\theta$	$A_x=A_R\sin\theta\cos\phi+A_\theta\cos\theta\cos\phi-A_\phi\sin\phi$ $A_y=A_R\sin\theta\sin\phi+A_\theta\cos\theta\sin\phi+A_\phi\cos\phi$ $A_z=A_R\cos\theta-A_\theta\sin\theta$
Cylindrical to Spherical	$R=\sqrt{r^2+z^2}$ $\theta=\tan^{-1}(r/z)$ $\phi=\phi$	$\hat{R}=\hat{r}\sin\theta+\hat{z}\cos\theta$ $\hat{\theta}=\hat{r}\cos\theta-\hat{z}\sin\theta$ $\hat{\phi}=\hat{\phi}$	$A_R=A_r\sin\theta+A_z\cos\theta$ $A_\theta=A_r\cos\theta-A_z\sin\theta$ $A_\phi=A_\phi$
Spherical to Cylindrical	$r=R\sin\theta$ $\phi=\phi$ $z=R\cos\theta$	$\hat{r}=\hat{R}\sin\theta+\hat{\theta}\cos\theta$ $\hat{\phi}=\hat{\phi}$ $\hat{z}=\hat{R}\cos\theta-\hat{\theta}\sin\theta$	$A_r=A_R\sin\theta+A_\theta\cos\theta$ $A_\phi=A_\phi$ $A_z=A_R\cos\theta-A_\theta\sin\theta$

Permittivity of free space, $\varepsilon_o=8.854\times10^{-12}F/m$

Permeability of free space, $\mu_o=4\pi\times10^{-7}T.m/A$